Palaeontological Impact Assessment for the proposed Deep E Opencast Mine, Zululand Anthracite Colliery, KwaZulu Natal Province

Desktop Study

For

Zululand Anthracite Colliery (Pty) Ltd

07 October 2018

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Expertise of Specialist

The Palaeontologist Consultant is: Prof Marion Bamford
Qualifications: PhD (Wits Univ, 1990); FRSSAf, ASSAf
Experience: 30 years research; 22 years PIA studies

Declaration of Independence

This report has been compiled by Professor Marion Bamford, of the University of the Witwatersrand, sub-contracted by Zululand Anthracite Colliery (Pty) Ltd, Empangeni, South Africa. The views expressed in this report are entirely those of the author and no other interest was displayed during the decision making process for the Project.

Specialist: Prof Marion Bamford

Signature: 

Executive Summary

A palaeontological Impact Assessment was requested for the development of the Deep E Opencast Mine for Zululand Anthracite Colliery, near Hlabisa in northern KwaZulu Natal. To comply with the South African Heritage Resources Agency (SAHRA) in terms of Section 38(8) of the National Heritage Resources Act, 1999 (Act No. 25 of 1999) (NHRA), a desktop Palaeontological Impact Assessment (PIA) was completed for the proposed development of a sand mining area.

The proposed site lies on the shales, mudstones sandstones and coals of the Emakwezini Formation (Beaufort Group) and Vryheid Formation (Ecca Group) of the eastern part of the Main Karoo Basin. While the coal seams themselves do not preserve recognisable plant fossils, the shale lenses and associated shales do preserve impressions of fossils of the Glossopteris flora and they have been recorded from Emakwazini Station to the south of the site. The coal seams and potentially fossiliferous shales are below ground, on average more than 20m below Fossils are unlikely to be seen on the surface but once excavations begin a monitoring programme and Chance Find Protocol should be added to the EMPr. Based on this information it is recommended that no palaeontological site visit is required until such time as excavations begin and if fossils are discovered.

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1. Background

A Palaeontological Impact Assessment was requested for the establishment of the Deep E Opencast Mine and associated infrastructure for Zululand Anthracite Colliery on the mining property. This will increase production by accessing the high quality anthracite reserves. The colliery is to the west of the town of Hlabisa, northern KwaZulu Natal.

To comply with the South African Heritage Resources Agency (SAHRA) in terms of Section 38(8) of the National Heritage Resources Act, 1999 (Act No. 25 of 1999) (NHRA), a desktop Palaeontological Impact Assessment (PIA) was completed for the proposed development of an opencast coal mine.

Table 1: Specialist report requirements in terms of Appendix 6 of the EIA Regulations (2014)

A specialist report prepared in terms of the Environmental Impact Regulations of 2014 must contain:	**Relevant section in report**
Details of the specialist who prepared the report	Appendix B
The expertise of that person to compile a specialist report including a curriculum vitae	Appendix B
A declaration that the person is independent in a form as may be specified by the competent authority	Page 1
An indication of the scope of, and the purpose for which, the report was prepared	Section 1
The date and season of the site investigation and the relevance of the season to the outcome of the assessment	N/A
A description of the methodology adopted in preparing the report or carrying out the specialised process	Section 2
The specific identified sensitivity of the site related to the activity and its associated structures and infrastructure	Section ii **Error! Reference source not found.**
An identification of any areas to be avoided, including buffers	N/A
A map superimposing the activity including the associated structures and infrastructure on the environmental sensitivities of the site including areas to be avoided, including buffers;	N/A
A description of any assumptions made and any uncertainties or gaps in knowledge;	Section 5
A description of the findings and potential implications of such findings on the impact of the proposed activity, including identified alternatives, on the environment	Section 4
Any mitigation measures for inclusion in the EMPr	n/a
Any conditions for inclusion in the environmental authorisation	n/a
Any monitoring requirements for inclusion in the EMPr or environmental authorisation	Section 8

A reasoned opinion as to whether the proposed activity or portions thereof should be authorised	N/A
If the opinion is that the proposed activity or portions thereof should be authorised, any avoidance, management and mitigation measures that should be included in the EMPr, and where applicable, the closure plan	N/A
A description of any consultation process that was undertaken during the course of carrying out the study	N/A
A summary and copies if any comments that were received during any consultation process	N/A
Any other information requested by the competent authority.	N/A

Figure 1: Google Earth map of the proposed site for the Deep E Opencast Mine for Zululand Anthracite Colliery. Map supplied by ZAC.

2. Methods and Terms of Reference

The Terms of Reference (ToR) for this study were to undertake a PIA and provide feasible management measures to comply with the requirements of SAHRA.

The methods employed to address the ToR included:

1. Consultation of geological maps, literature, palaeontological databases, published and unpublished records to determine the likelihood of fossils occurring in the affected areas. Sources included records housed at the Evolutionary Studies Institute at the University of the Witwatersrand and SAHRA databases;
2. Where necessary, site visits by a qualified palaeontologist to locate any fossils and assess their importance (*not applicable to this assessment*);
3. Where appropriate, collection of unique or rare fossils with the necessary permits for storage and curation at an appropriate facility (*not applicable to this assessment*); and
4. Determination of fossils' representivity or scientific importance to decide if the fossils can be destroyed or a representative sample collected (*not applicable to this assessment*).

3. Geology and Palaeontology

i. Project location and geological context

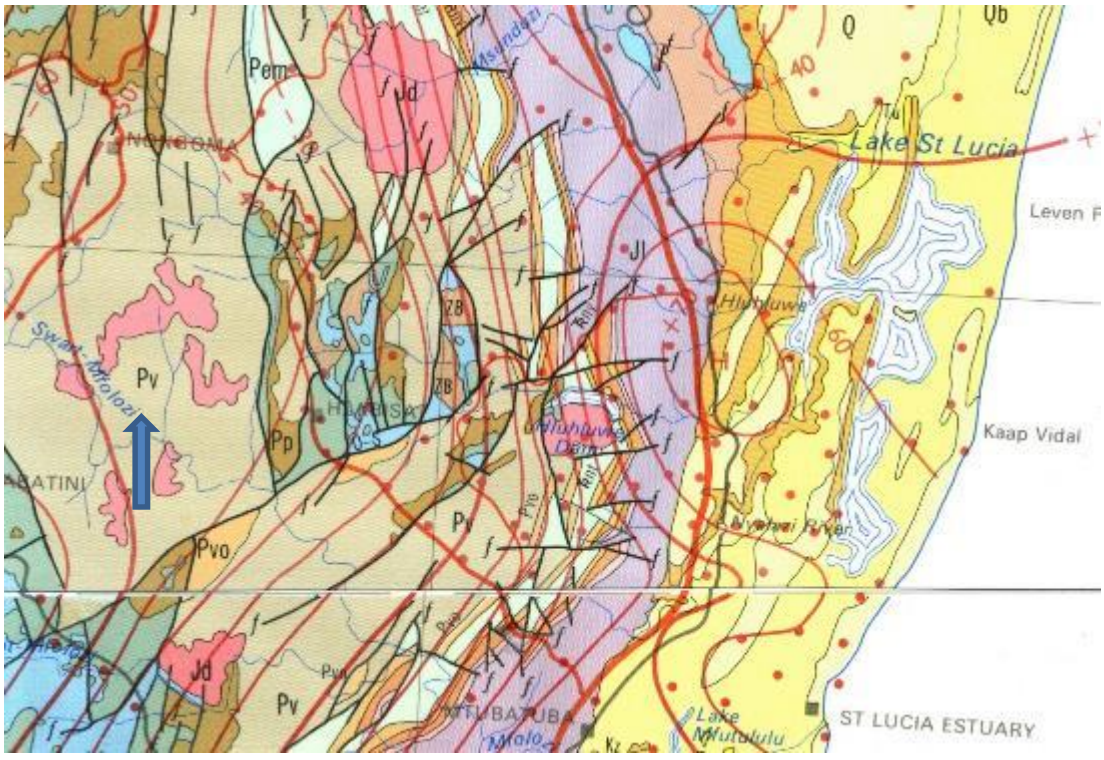

Figure 2: Geological map of the area around the Zululand Anthracite Colliery in northern KwaZulu Natal. The location of the proposed project is indicated with the arrow. Abbreviations of the rock types are explained in Table 2. Map enlarged from the Geological Survey 1: 1 000 000 map 1984.

Table 2: Explanation of symbols for the geological map and approximate ages (Duncan and Marsh, 2006; Erikssen et al., 2006. Johnson et al., 2006; McCarthy et al., 2006; Marshall, 2006; van der Westhuizen et al., 2006). SG = Supergroup; Fm = Formation.

Symbol	Group/Formation	Lithology	Approximate Age
Q	Quaternary	Alluvium, sand, calcrete	Neogene, ca 25 Ma to present
Qb	Port Durnford	Aeolinaite, sandstone, clay,limestone	Neogene
Kz	Zululand Group	Siltstone, sandstone, conglomerate	Cretaceous
Jj	Jozini Fm, Lebombo Group	Rhyodactite	Jurassic Ca 150 Ma
Jl	Letaba, Lebombo Group	Picritic basalt	Jurassic, ca 150 Ma
Jd	Jurassic dykes	Dolerite dykes, intrusive	Jurassic, approx. 180 Ma
Tr-nt	Ntabeni Fm,	sandstone	Molteno, Carnian-Norian
Pem	Emakwezini Fm, Beaufort Group	Mudstone, shale, sandstone	>250 Ma
Pvo	Volksrust Fm, Ecca Group	shale	Permian middle, Upper Ecca
Pv	Vryheid Fm, Ecca Group	Shales, sandstone, coal	Lower Permian, Middle Ecca
Pp	Pietermaritzburg Fm, Ecca Group	Shale	Lower Ecca, early Permian
C-Pd	Dwyka Group	Tillite, sandstone, mudstone, shale	Late Carbonifereous to early Permian
O-S	Natal Group	Quartzitic sandstone, arkose, shale	Ordovician to Silurian
ZB	Basement complex	Potassic Granite, granodiorite	>3100 Ma

Northern KwaZulu Natal is underlain by coal deposits in three main areas, Nongoma, Somkele and Zululand Anthracite of Permian age. The oldest rocks in the area are the basement of Late Archean age and are part of the Kaap-Vaal Craton, comprising a number of granites and granodiorites. Unconformably overlying these rocks are the quartzitic sandstones and shales of the Natal Group. The overlying Dwyka tillites represent the deposits from the receding glaciers during the Upper Carboniferous. The next stratum is the Pietermaritzburg Formation shales that represent a major post-glacial transgression and a relatively shallow water setting (Johnson et al., 2006). It is the lowermost part of the Ecca Group of the Karoo Supergroup.

The Vryheid and Volksrust Formations are widespread in this area and the former has a number of coal lenses. In contrast the Volksrust Formation, comprising grey to black silty shales, represents a transgressive and possibly open shelf sequence made up mostly of muds that were deposited from suspension (Johnson et al., 2006). The Zululand Anthracite Colliery utilises coal from two Formations, namely the Vryheid Formation and the slightly younger Emakwezini Formation. The main seam is in the Vryheid Formation and produces very high quality coal (anthracite). In contrast Emakwezini Formation has three coal seams of inferior quality (Snyman, 1998, p. 186).

Also in the region are the Triassic Ntabeni formation, the Lebombo volcanic rocks, the Cretaceous Zululand rocks that include coastal and terrestrial deposits (Shone, 2006), and farther to the east are the overlying Quaternary sandstones.

ii. Palaeontological context

The palaeontological sensitivity of the area under consideration is presented in Figure 3. The coal colliery lies in the Vryheid Formation, middle Ecca Group and also the Emakwezini Formation (Beaufort Group) and these strata contain coal seams that are exploited by the mine.

Coal is the result of peats (dead plant material) that have been compressed and altered by heat over millions of years so coal is not of interest palaeontologically because none of the original plant material can be recognised. However, the shales between the coal seams can preserve impressions of the plants that formed the coals, namely *Glossopteris* leaves, seeds, reproductive structures, lycopods, sphenophytes, ferns and rare gymnosperms.

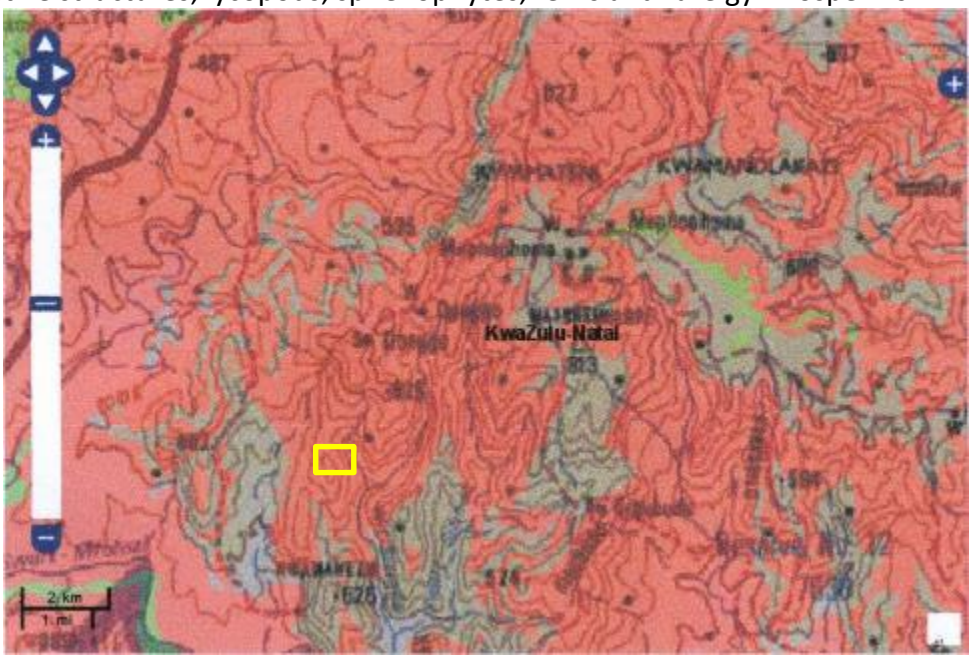

Figure 3: SAHRIS palaeosensitivity map for the site for the proposed Deep E opencast Mine for Zululand Anthracite Colliery shown within the yellow rectangle. Colours indicate the following degrees of sensitivity: red = very highly sensitive; orange/yellow = high; green = moderate; blue = low; grey = insignificant/zero.

To date no fossils have been reported from the Zululand Anthracite colliery but they have been reported from drill core in the Somkele Coal field (Plumstead, 1969) and from surface exposures at Emakwezini Station, KwaYaya and Somkele Mine (Anderson and Anderson, 1985; Bordy and Prevec, 2008). Species lists and photographs of the fossil plants from the Emkwezini Formation are reproduced in Appendix A taken from Bordy and Prevec (2008).

Vertebrate fossils are extremely rare but have been reported from the Normandien Formation to the west of this project site.

From the SAHRIS map above the area is indicated as highly sensitive (red) so a desktop study is presented here. On average coal seams and shales are more than 20m below the land surface (see profiles in Snyman, 1998). Excavations for the adit have not yet commenced and so the occurrence of fossils in the site is as yet unknown.

4. Impact assessment

An assessment of the potential impacts to possible palaeontological resources considers the criteria encapsulated in Table 3:

TABLE 3A: CRITERIA FOR ASSESSING IMPACTS

PART A: DEFINITION AND CRITERIA		
Criteria for ranking of the SEVERITY/NATURE of environmental impacts	**H**	Substantial deterioration (death, illness or injury). Recommended level will often be violated. Vigorous community action.
	M	Moderate/ measurable deterioration (discomfort). Recommended level will occasionally be violated. Widespread complaints.
	L	Minor deterioration (nuisance or minor deterioration). Change not measurable/ will remain in the current range. Recommended level will never be violated. Sporadic complaints.
	L+	Minor improvement. Change not measurable/ will remain in the current range. Recommended level will never be violated. Sporadic complaints.
	M+	Moderate improvement. Will be within or better than the recommended level. No observed reaction.
	H+	Substantial improvement. Will be within or better than the recommended level. Favourable publicity.
Criteria for ranking the DURATION of impacts	**L**	Quickly reversible. Less than the project life. Short term
	M	Reversible over time. Life of the project. Medium term
	H	Permanent. Beyond closure. Long term.
Criteria for ranking the SPATIAL SCALE of impacts	**L**	Localised - Within the site boundary.
	M	Fairly widespread – Beyond the site boundary. Local
	H	Widespread – Far beyond site boundary. Regional/ national
PROBABILITY (of exposure to impacts)	**H**	Definite/ Continuous
	M	Possible/ frequent
	L	Unlikely/ seldom

TABLE 3B: IMPACT ASSESSMENT

PART B: ASSESSMENT		
SEVERITY/NATURE	**H**	-
	M	There is a fair chance that fossil plants will occur close to the coal seams so the impact would be moderate.
	L	-
	L+	-
	M+	-
	H+	-
DURATION	**L**	-
	M	-
	H	Where manifest, the impact will be permanent.

PART B: ASSESSMENT		
SPATIAL SCALE	**L**	Since only the possible fossils within the area would be fossil plants from the *Glossopteris* flora in the shales, the spatial scale will be localised within the site boundary.
	M	-
	H	-
PROBABILITY	**H**	**-**
	M	It is likely that fossil plants will be found in the shales associated with the coal seams once excavations have begun so a chance find protocol should be added to the eventual EMPr
	L	.

Based on the nature of the project, surface activities are unlikely to impact on the fossil heritage given that the coal seams and associated potentially fossiliferous shales are on average more than 20m below the surface. The upper coal seams, of the Emakwezini Formation, in the core taken from Somkele coal mine have sparsely distributed fossil plant impressions of the *Glossopteris* flora. Fossils are more abundant in railway cuttings at the Emakwezini Station, at KwaYaya and in the Somkele Mine open cast pit. Since there is a fair chance that fossils from the Emakwezini and Vryheid Formations may be disturbed a Chance find protocol has been added to this report. Taking account of the defined criteria, the potential impact to fossil heritage resources is fair to moderate but only once excavation and mining activities have penetrated below the surface.

5. Assumptions and uncertainties

Based on the geology of the area and the palaeontological record as we know it, it can be assumed that the formation and layout of the dolomites, sandstones, shales, coals and sands are typical for the country and do contain fossil plant, insect, invertebrate and vertebrate material. Although not reported to date from the Zululand Anthracite Colliery it can be assumed that fossil plant impressions of the Glossopteris flora could occur in the Emakwezini and Vryheid Formations at this site because they have been reported from these formations to the south.

6. Recommendation

Based on experience and the lack of any previously recorded fossils from the area, it is nonetheless possible that fossil plant impressions could occur at the site but not on the surface, possibly below about 20m or where the uppermost coal seam occurs with its associated shale lenses. It is recommended, therefore, that a Fossil Chance Find Protocol be added to the EMPr such that once excavations for the Deep E Opencast Mine have commenced the geologist, environmentalist or other responsible person looks out for fossils and reports any occurrences to a professional palaeontologist for assessment of the scientific value, and to make a representative collection once an AMAFA permit has been obtained.

7. References

Anderson, J.M., Anderson, H.M., 1985. Palaeoflora of Southern Africa: Prodromus of South African megafloras, Devonian to Lower Cretaceous. A.A. Balkema, Rotterdam. 423 pp.

Bordy, E.M., Prevec, R. 2008. Sedimentology, palaeontology and palaeo-environments of the Middle (?) to Upper Permian Emakwezini Formation (Karoo Supergroup, South Africa). South African Journal of Geology 111, 429-458.

Duncan, A.R., Marsh, J.S., 2006. The Karoo Igneous Province. In: Johnson, M.R., Anhaeusser, C.R. and Thomas, R.J., (Eds). The Geology of South Africa. Geological Society of South Africa, Johannesburg / Council for Geoscience, Pretoria. Pp 501-520.

Johnson, M.R., van Vuuren, C.J., Visser, J.N.J., Cole, D.I., Wickens, H.deV., Christie, A.D.M., Roberts, D.L., Brandl, G., 2006. Sedimentary rocks of the Karoo Supergroup. In: Johnson, M.R., Anhaeusser, C.R. and Thomas, R.J., (Eds). The Geology of South Africa. Geological Society of South Africa, Johannesburg / Council for Geoscience, Pretoria. Pp 461 – 499.

Marshall, G.G.A., 2006. The Natal Group. In: Johnson, M.R., Anhaeusser, C.R. and Thomas, R.J., (Eds). The Geology of South Africa. Geological Society of South Africa, Johannesburg / Council for Geoscience, Pretoria. Pp 433-441.

Plumstead, E.P., 1969. Three thousand million years of plant life in Africa. Geological Society of southern Africa, Annexure to Volume LXXII. 72pp + 25 plates.

Snyman, C.P., 1998. Coal. In: Wilson, M.G.C., and Anhaeusser, C.P., (Eds) The Mineral Resources of South Africa: Handbook, Council for Geosciences 16, 136-205

8. Chance Find Protocol

Monitoring Programme for Palaeontology – to commence once the excavations or mining begin.

1. The following procedure is only required if fossils are seen on the surface or and when excavations/mining commence.
2. When excavations begin the rocks and must be given a cursory inspection by the environmental officer or designated person. Any fossiliferous material (plants, insects, bone, coal) should be put aside in a suitably protected place. This way the mining activities will not be interrupted.
3. Photographs of similar fossil plants must be provided to the developer to assist in recognizing the fossil plants in the shales and mudstones (for example see Figures 4, 5). This information will be built into the EMP's training and awareness plan and procedures.
4. Photographs of the putative fossils can be sent to the palaeontologist for a preliminary assessment.
5. If there is any possible fossil material found by the developer/environmental officer/miners then the qualified palaeontologist sub-contracted for this project, should visit the site to inspect the selected material and check the dumps where feasible.
6. Fossil plants or vertebrates that are considered to be of good quality or scientific interest by the palaeontologist must be removed, catalogued and housed in a suitable institution where they can be made available for further study. Before the fossils are removed from the site a SAHRA or AMAFA permit must be obtained. Annual reports must be submitted to SAHRA as required by the relevant permits.
7. If no good fossil material is recovered then the site inspections by the palaeontologist will not be necessary. Annual reports by the palaeontologist must be sent to SAHRA.
8. If no fossils are found and the excavations have finished then no further monitoring is required.

Appendix A – List of Fossil Plants and Photographs

(from Anderson and Anderson, 1985; Bordy and Prevec, 2008).

Plant Group	Genus and species	Emkwezini Station	KwaYaya	Somkele Seam B
Glossopteridales	*Glossopteris spp.*	+	+	+
	Rigbya arberioides	+	+	
	Dictyopteridium flabellatum	+		
	Plumsteadia gibbosa		+	
	Lidgettonia africana	+	+	
	Lidgettonia lidgettonioides	+		
	Ottokaria spp			+
	Samaropsis seeds var	+	+	
	Eretmonia natalensis	+	+	
	Arberialla sp.	+	+	
	Scale leaves	+		
	Vertebraria indica	+	+	+
Sphenopsida	*Phyllotheca australis*	+	+	
	Paracalamites australis	+	+	
	Schizoneura gondwananensis			+
	Trizygia speciosa		+	
	Raniganjia kilburnensis	+		
Incertae sedis	*Benlightfootia sp.*		+	

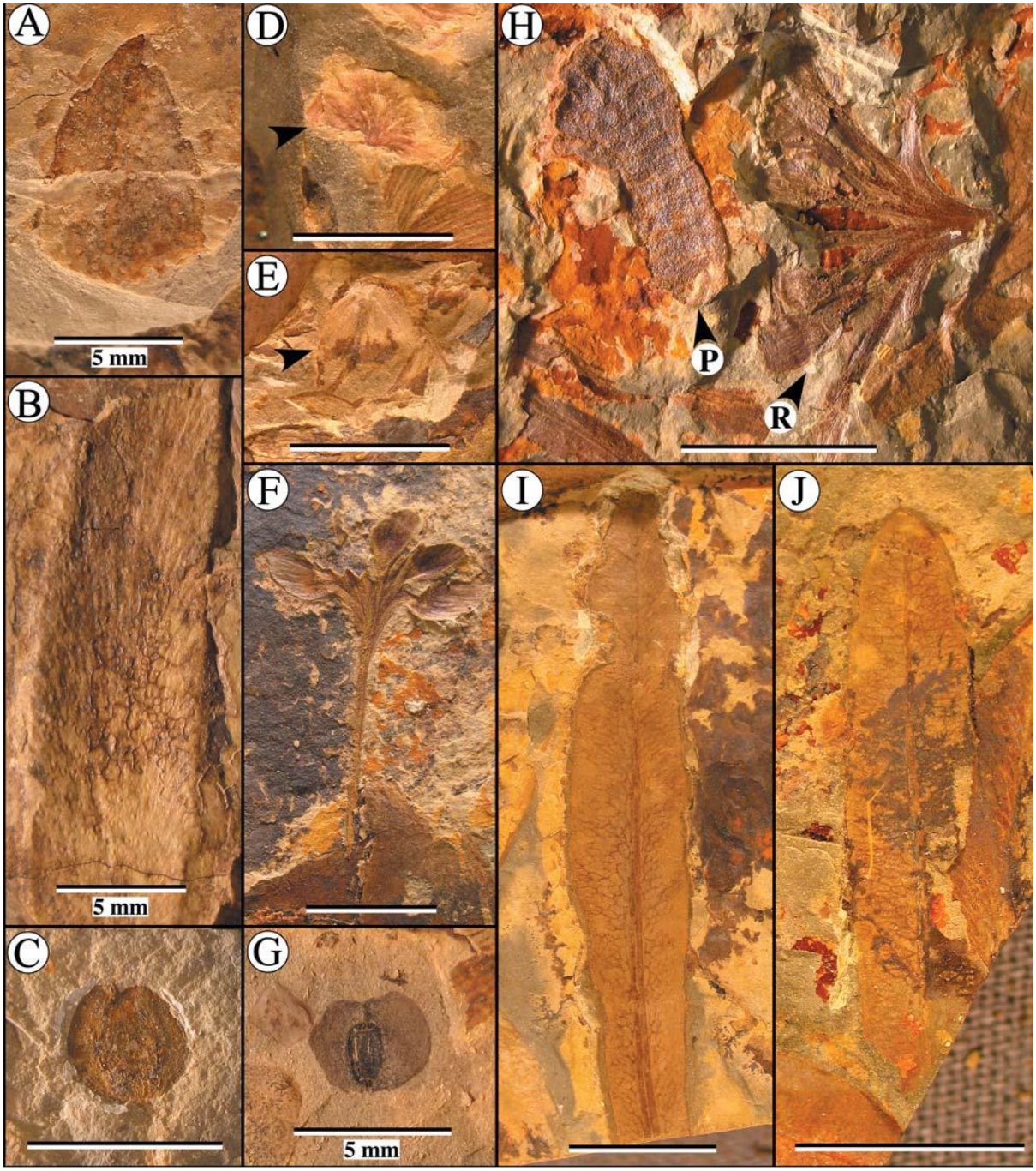

Figure 4: Examples of fossil plants found in the Emakwezini Formation (taken from Bordy and Prevec, 2008, plate 1)

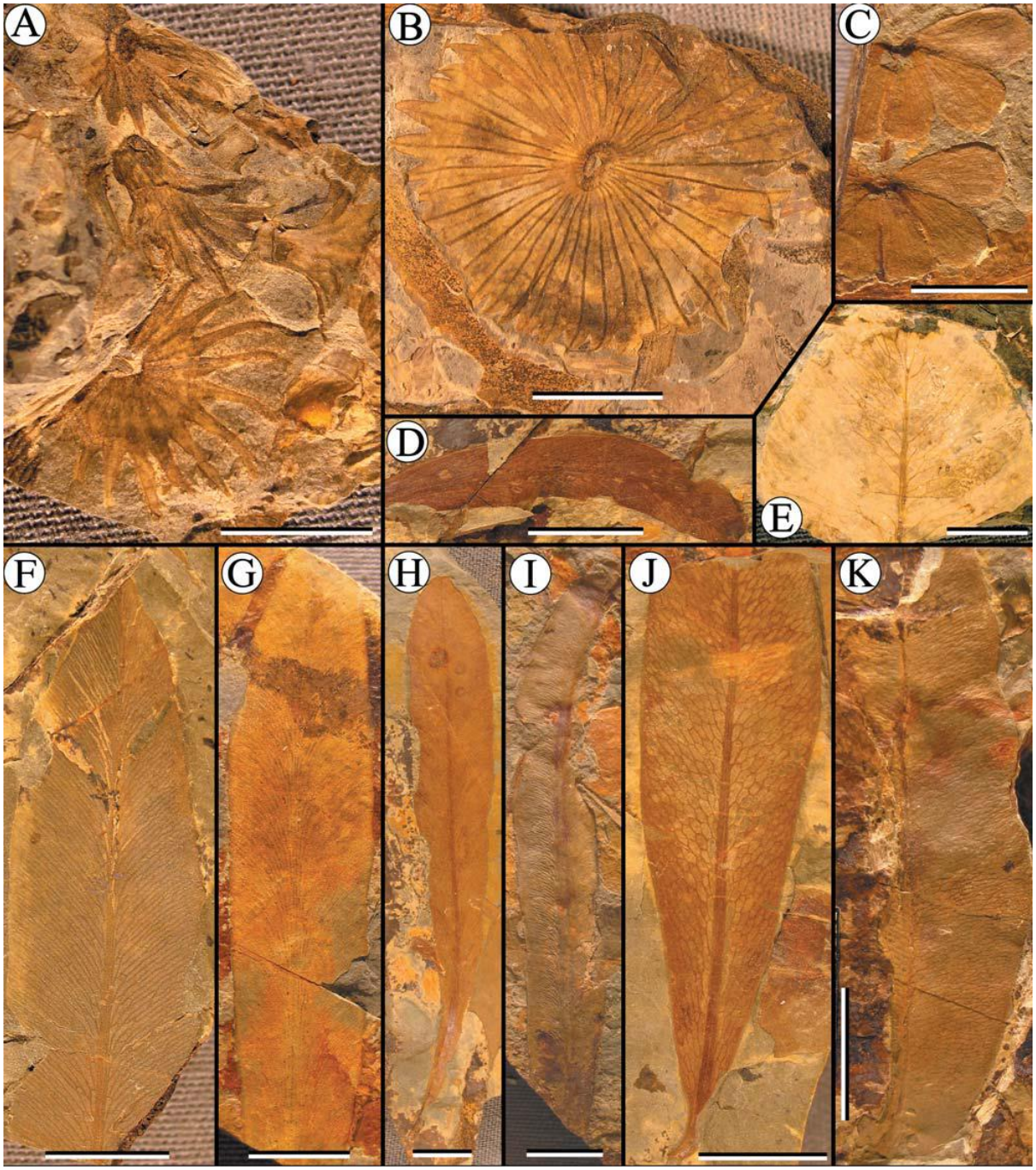

Figure 5: More examples of fossil plants from the Emakwezini Formation (taken from Bordy and Prevec, 2008, plate II)

Appendix B – Details of specialist

Curriculum vitae (short) - Marion Bamford PhD
June 2018

I) Personal details

Surname	:	**Bamford**
First names	:	**Marion Kathleen**
Present employment	:	Professor; Director of the Evolutionary Studies Institute. Member Management Committee of the NRF/DST Centre of Excellence Palaeosciences, University of the Witwatersrand, Johannesburg, South Africa-
Telephone	:	+27 11 717 6690
Fax	:	+27 11 717 6694
Cell	:	082 555 6937
E-mail	:	marion.bamford@wits.ac.za ; marionbamford12@gmail.com

ii) Academic qualifications

Tertiary Education: All at the University of the Witwatersrand:
1980-1982: BSc, majors in Botany and Microbiology. Graduated April 1983.
1983: BSc Honours, Botany and Palaeobotany. Graduated April 1984.
1984-1986: MSc in Palaeobotany. Graduated with Distinction, November 1986.
1986-1989: PhD in Palaeobotany. Graduated in June 1990.

iii) Professional qualifications

Wood Anatomy Training (overseas as nothing was available in South Africa):
1994 - Service d'Anatomie des Bois, Musée Royal de l'Afrique Centrale, Tervuren, Belgium, by Roger Dechamps
1997 - Université Pierre et Marie Curie, Paris, France, by Dr Jean-Claude Koeniguer
1997 - Université Claude Bernard, Lyon, France by Prof Georges Barale, Dr Jean-Pierre Gros, and Dr Marc Philippe

iv) Membership of professional bodies/associations

Palaeontological Society of Southern Africa
Royal Society of Southern Africa - Fellow: 2006 onwards
Academy of Sciences of South Africa - Member: Oct 2014 onwards
International Association of Wood Anatomists - First enrolled: January 1991
International Organization of Palaeobotany – 1993+
Botanical Society of South Africa
South African Committee on Stratigraphy – Biostratigraphy - 1997 - 2016

SASQUA (South African Society for Quaternary Research) – 1997+
PAGES - 2008 –onwards: South African representative
ROCEEH / WAVE – 2008+
INQUA – PALCOMM – 2011+onwards

vii) Supervision of Higher Degrees

All at Wits University

Degree	Graduated/completed	Current
Honours	6	1
Masters	8	1
PhD	10	2
Postdoctoral fellows	9	3

viii) Undergraduate teaching
Geology II – Palaeobotany GEOL2008 – average 65 students per year
Biology III – Palaeobotany APES3029 – average 25 students per year
Honours – Evolution of Terrestrial Ecosystems; African Plio-Pleistocene Palaeoecology; Micropalaeontology – average 2-8 students per year.

ix) Editing and reviewing
Editor: Palaeontologia africana: 2003 to 2013; 2014 – Assistant editor
Guest Editor: Quaternary International: 2005 volume
Member of Board of Review: Review of Palaeobotany and Palynology: 2010 –
Cretaceous Research: 2014 -

Review of manuscripts for ISI-listed journals: 25 local and international journals

x) Palaeontological Impact Assessments

Selected – list not complete:

- Thukela Biosphere Conservancy 1996; 2002 for DWAF
- Vioolsdrift 2007 for Xibula Exploration
- Rietfontein 2009 for Zitholele Consulting
- Bloeddrift-Baken 2010 for TransHex
- New Kleinfontein Gold Mine 2012 for Prime Resources (Pty) Ltd.
- Thabazimbi Iron Cave 2012 for Professional Grave Solutions (Pty) Ltd
- Delmas 2013 for Jones and Wagener
- Klipfontein 2013 for Jones and Wagener
- Platinum mine 2013 for Lonmin
- Syferfontein 2014 for Digby Wells
- Canyon Springs 2014 for Prime Resources
- Kimberley Eskom 2014 for Landscape Dynamics
- Yzermyne 2014 for Digby Wells
- Matimba 2015 for Royal HaskoningDV

- Commissiekraal 2015 for SLR
- Harmony PV 2015 for Savannah Environmental
- Glencore-Tweefontein 2015 for Digby Wells
- Umkomazi 2015 for JLB Consulting
- Ixia coal 2016 for Digby Wells
- Lambda Eskom for Digby Wells
- Alexander Scoping for SLR
- Perseus-Kronos-Aries Eskom 2016 for NGT
- Mala Mala 2017 for Henwood
- Modimolle 2017 for Green Vision
- Klipoortjie and Finaalspan 2017 for Delta BEC
- Ledjadja borrow pits 2018 for Digby Wells
- Lungile poultry farm 2018 for CTS
- Olienhout Dam 2018 for JP Celliers
- Isondlo and Kwasobabili 2018 for GCS
- Kanakies Gypsum 2018 for Cabanga
- Nababeep Copper mine 2018
- Glencore-Mbali pipeline 2018 for Digby Wells
-

xi) Research Output

Publications by M K Bamford up to June 2018 peer-reviewed journals or scholarly books: over 120 articles published; 5 submitted/in press; 8 book chapters.
Scopus h index = 26; Google scholar h index = 28;
Conferences: numerous presentations at local and international conferences.

xii) NRF Rating

NRF Rating: B-2 (2016-2020)
NRF Rating: B-3 (2010-2015)
NRF Rating: B-3 (2005-2009)
NRF Rating: C-2 (1999-2004)